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Research Article

A new combination and a new synonym of Gesneriaceae in China

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Abstract

Didymocarpus subpalmatinervis W.T.Wang was shown to be conspecific with *Petrocodon lithophilus* Y.M.Shui, W.H.Chen & Mich.Möller, by checking original literature, examining specimens, tracing specimen collecting history, and conducting field surveys. The results show morphological characteristics and geographical distribution overlaps between these two species. The transfer of *Didymocarpus subpalmatinervis* to *Petrocodon* as a new combination with *Petrocodon subpalmatinervis* (W.T.Wang) F.Wen & Z.L.Li is proposed here, and *P. lithophilus* is synonymized with *P. subpalmatinervis*. Color photographs and essential information are also provided, including a detailed comparison of description, distribution, habitat, and the proposed IUCN conservation status.

Key words: *Didymocarpus*, Flora of China, Gesneriaceae, new combination, new synonym, *Petrocodon*, taxonomy

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Introduction

Didymocarpus Wall. has a complex taxonomic history, saturated with doubtful taxa (Weber and Burtt 1998). Originally, in the taxonomic system of Burtt and Wiehler (1995), it was the largest genus in the tribe Didymocarpeae Endl., subfam. Cyrtandroideae, with more than 180 species. Weber and Burtt (1998) excluded the section *Heteroboea*, which was considered as part of *Didymocarpus s. l* (Hilliard and Burtt 1995; Weber and Burtt 1998). In addition, they considered that 1) *D. hancei* Hemsl. (endemic to China) and *D. bonii* Pellegr. (distributed in Vietnam and East Thailand) should be included in *Calcareoboea* C.Y.Wu ex H.W.Li, as well as *D. mollifolius* W.T,Wang and *D. niveolanosus* D.Fang & W.T.Wang; 2) *D. demissus* Hance should be assigned to the previous genus, *Chirita* Buch.-Ham. ex D. Don (Wei et al. 2010; Wang et al. 2011; Weber et al.

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2011). Their notion of separating *D. hancei* from *Didymocarpus* Wall. was supported by Li (2007) based on morphological and molecular evidence. Weber et al. (2011) published three new combinations in their revision of the genus *Petrocodon* Hance, viz., *Petrocodon hancei* (Hemsl.) A.Weber & Mich.Möller (≡*Didymocarpus hancei* Hemsl.), *Petrcodon mollifolius* (W.T.Wang) A.Weber & Mich.Möller (≡*Didymocarpus mollifolius* W.T.Wang) and *Petrocodon niveolanosus* (D.Fang & W.T.Wang) A.Weber & Mich.Möller (≡*Didymocarpus niveolanosus* D.Fang & W.T.Wang). *D. subpalmatinervis* W.T.Wang, a species with no collection record after 1905, also has morphological characteristics placing it in section *Heteroboea*. The taxonomic status of this species remained unchanged because of the difficulty in obtaining type materials. Its problematic taxonomic status has previously been recognized by (Li et al. 2015; Möller et al. 2016; Hong et al. 2018).

The French Catholic priest Francois Ducloux (1864–1945), the head of the Kunming Church from 1889 to 1945, hired people to collect plant specimens extensively in central and northern Yunnan (Qu 2014). In 1905, Ducloux collected a Gesneriaceae-like taxon, perennial and acaulescent in Y-dje, near Loulan, Yunnan, China (collection number *Fr. Ducloux 3711*). He sent three sheets back to the Museum of Natural History in Paris. Since then, those specimens were neglected in P for over 90 years, until in 1996, Wen-Tsai Wang identified Ducloux's specimens as a new species belonging to *Didymocarpus* sect. *Heteroboea* and published it as *Didymocarpus subpalmatinervis* subsequently a year later (Weitzman et al. 1997).

Petrocodon lithophilus was described at the morphological and molecular level from Naigu Stone Forest, Yunnan Province, where Michael Möller and Yu-Min Shui first discovered it in August 2012. It is placed in *Petrocodon* by some obvious characters of this genus, *viz*. a rhizomatous rosette with leaves usually rounded or elliptic, mainly in an alternate arrangement, filaments straight, stigma discoid, and fruits dehiscing loculicidally into two valves (Chen et al. 2014).

When sorting out the specimens of *Didymocarpus* sect. *Heteroboea* of, the type specimen of *D. subpalmatinervis* (*Fr. Ducloux 3711*), morphologically, was found to be extremely similar to *Petrocodon lithophilus*. According to protologue and label information on the type specimen, the type locality of *Didymocarpus subpalmatinervis* is near Lunan Stone Forest, only 13 kilometers away from Naigu Stone Forest. During field investigations near the type locality of *Petrocodon lithophilus*, several populations of *Didymocarpus* aff. *subpalmatinervis* were also found on the hills. The authors concluded that *D. subpalmatinervis* is conspecific with *Petrocodon lithophilus*. Accordingly, it is reasonable to make a new combination *P. subpalmatinervis*, and reduce *P. lithophilus* to a synonym.

Materials and methods

A thorough comparison of the type material of *Petrocodon lithophilus* and *Didymocarpus subpalmatinervis* was made. Their protologues and relevant records were studied intensively. The geographical distribution of the two species was outlined by careful field surveys of the type locality areas. Classical plant taxonomic methods were involved. Major online herbarium databases, including **P** (https://science.mnhn.fr/institution/mnhn/search), **E** (http://www.rbge.

org.uk/), **K** (https://www.kew.org/), **A** (https://huh.harvard.edu/), **PE** (https://pe.ibcas.ac.cn/index.html) and Chinese Virtual Herbarium (https://www.cvh.ac.cn/), et al., were checked. The only recorded specimens of *D. subpalmatinervis* stored at **P** were affirmed and checked, utilizing high-resolution digital images of the type specimen. In addition, the authors observed and recorded morphological characters of *Petrocodon lithophilus* in the field and examined its type specimen at **KUN**.

Results

Comparison and discussion of morphological characteristics of sect. *Heteroboea*

There are numerous distinct morphological characteristics distinguishing *Didymocarpus subpalmatinervis* from other species within sect. *Heteroboea*, such as leaves' margins obtusely or doubly dentate (*vs.* margin irregularly triangular denticulate), triangular lobes (*vs.* rounded or oblong lobes), straight filaments (*vs.* curving), separate anthers (*vs.* confluent anthers). Detailed morphological comparisons with sect. *Heteroboea* are provided in Fig. 1. Based on the aforementioned, it becomes evident that *D. subpalmatinervis* is not a species within sect. *Heteroboea*. Additionally, owing to its stemless habit, it does not align with sect. *Didymocarpus* either. Consequently, the taxonomic classification of this species falls outside the scope of the *Didymocarpus* genus. Given its overall vegetative traits, it should be reclassified under the genus *Petrocodon*.

Comparison and discussion of morphological description with *Petrocodon lithophilus*

Comparing the description of *Didymocarpus subpalmatinervis* and *Petrocodon lithophilus* in their protologues, we found consistency in habit, leaves, calyx, corolla, disc, and ovary (indicated by "●" in Table 1). Because Wen-Tsai Wang described *D. subpalmatinervis* (Weitzman et al. 1997) according to the over 90-year-old type specimen, there may be some distortion compared with wild-living plants in morphology. Moreover, terminology may alter to a certain degree among different taxonomists due to personal preference in the use of words. Taxonomic descriptions have evolved over the years, as have identification tools. For example, Wang selected 'puberulous' and Shui picked up 'pubescent' to describe the hair of *Didymocarpus subpalmatinervis* and *Petrocodon lithophilus*, respectively. Such equivalents used by them in the description are marked with "★" in Table 1. The only significant difference appeared in the statement of staminode's number: 2 in *Didymocarpus subpalmatinervis* and 3 in *Petrocodon lithophilus* (indicated by "▲" in Table 1). This feature has already been questioned by Wen et al. (2020). Previous researchers often made mistakes in describing the number of staminodes because 1) they followed generic diagnoses of *Didymocarpus* and paid no attention to the actual stamineal condition; 2) staminodes are inconspicuous in many species unless they are carefully observed, but the correct number of staminodes is 3. Detailed morphological comparisons with *P. lithophilus* are provided in Fig. 2.

Figure 1. Morphological comparisons of *Didymocarpus subpalmatinervis* and sect. *Heteroboea* **A** type specimen of *D. subpalmatinervis* **B** habit of *D. heucherifolius* var. *yinzhengii* **C** habit of *D. cortusifolius* **D** habit of *D. yuenlingensis* **E** habit of *D. heucherifolius* var. *gamosepalus* **F** leaves of *D. subpalmatinervis* **G** leaves of *D. heucherifolius* var. *yinzhengii* **H** leaves of *D. lobulatus* **I** leaves of *D. heucherifolius* **J** opened corolla of *D. subpalmatinervis*, showing lobes and stamens **K** frontal view of *D. yuenlingensis*, showing lobes and stamens **L** frontal view of *D. cortusifolius*, showing lobes and stamens **M** frontal view of *D. sinoprimulinus*, showing lobes and stamens.

The similarity in protologues prompts us to reconsider the circumscription of *Didymocarpus subpalmatinervis* and *Petrocodon lithophilus*.

Locality

In 1905, Ducoux collected *Didymocarpus subpalmatinervis* at the position of Y-dje, near Lou-lan. Lou-lan is the French pronunciation of 路南 (Lùnán) in

Table 1. The description and comparison of the *D. subpalmatinervis and P. lithophilus*.

		Didymocarpus subpalmatinervis W.T.Wang	*Petrocodon lithophilus* Y.M.Shui, W.H.Chen & Mich.Möller	The similarity in description between the two species
Habit		Perennial, stemless herb	Perennial herbs	●
Leaves	**shape**	leaf blade ovate to oblate	leaf blade rounded or elliptic	★
	hair	adaxially densely appressed puberulous, abaxially appressed puberulous, pilose on veins	pubescent on both surfaces	★
	base	cordate	nearly cordate	●
	margin	obtusely or doubly dentate	shallowly or deeply crenulate	★
	apex	obtuse	rounded	★
Cymes	**number**	Cymes ca. 2, ca. 2× branched, 2–10–flowered;	about10 flowers	★
	peduncle	puberulous	pubescent	★
	bracts	2–3, narrowly lanceolate or linear, puberulous	2, linear or lanceolate, pubescent	★
	Calyx	Calyx actinomorphic, 5-sect or nearly so, segments linear-triangular, both surfaces puberulous	Calyx 5-lobed to base, segments linear, pubescent	●
Corolla	**color**	Yellow	light greenish-yellow	●
	length	2–2.5 cm	2.5–2.8 cm	★
	tube	funnelform-cylindric, 1.4–1.7 cm	thin tubular, 1.7–1.9 cm	★
	lobes	upper lip 2-lobed, lower lip 3-lobed, all lobes triangular	adaxial lip 2-lobed, lobes triangular, abaxial lip 3-lobed, lobes triangular	●
Stamens	**staminodes**	2	3	▲
Disc		annular	ring-like	●
Pistil	**ovary**	ovary linear	ovary linear inflated	●
	hairs	puberulous	pubescent	★
	stigma	depressed capitate	stigma 1, disc-like and undivided	★

● Completely consistent characteristics; ★ Overlapping characteristics; ▲ Different characteristics.

Chinese, and Y-dje corresponds to 维则 (Wéizé). The scope of Lou-lan is not indicated on the type specimens of *D. subpalmatinervis*. China in 1905 was still in the era of the Qing Dynasty. Lunan then refers to Lunanzhou, which is now Shilin County. Naigu Stone Forest is included in Lunan County (now Shilin County). Lunan refers to Lunan Stone Forest. Lunan Stone Forest and Naigu Stone Forest are both in the Stone Forest scenic spot today. Our field survey shows only one species of Gesneriaceae with similar morphological characteristics in these two regions. The distribution of the two species thus overlaps no matter which geographical entity Lunan refers to in the past or present.

In summary, based on literature research, geographical distribution, and morphological analysis, we find no discontinuities and recognize *Didymocarpus subpalmatinervis* and *Petrocodon lithophilus* as conspecific. Therefore, a new combination, *P. subpalmatinervis* (W.T.Wang) F.Wen & Z.L.Li, comb. nov. is proposed here.

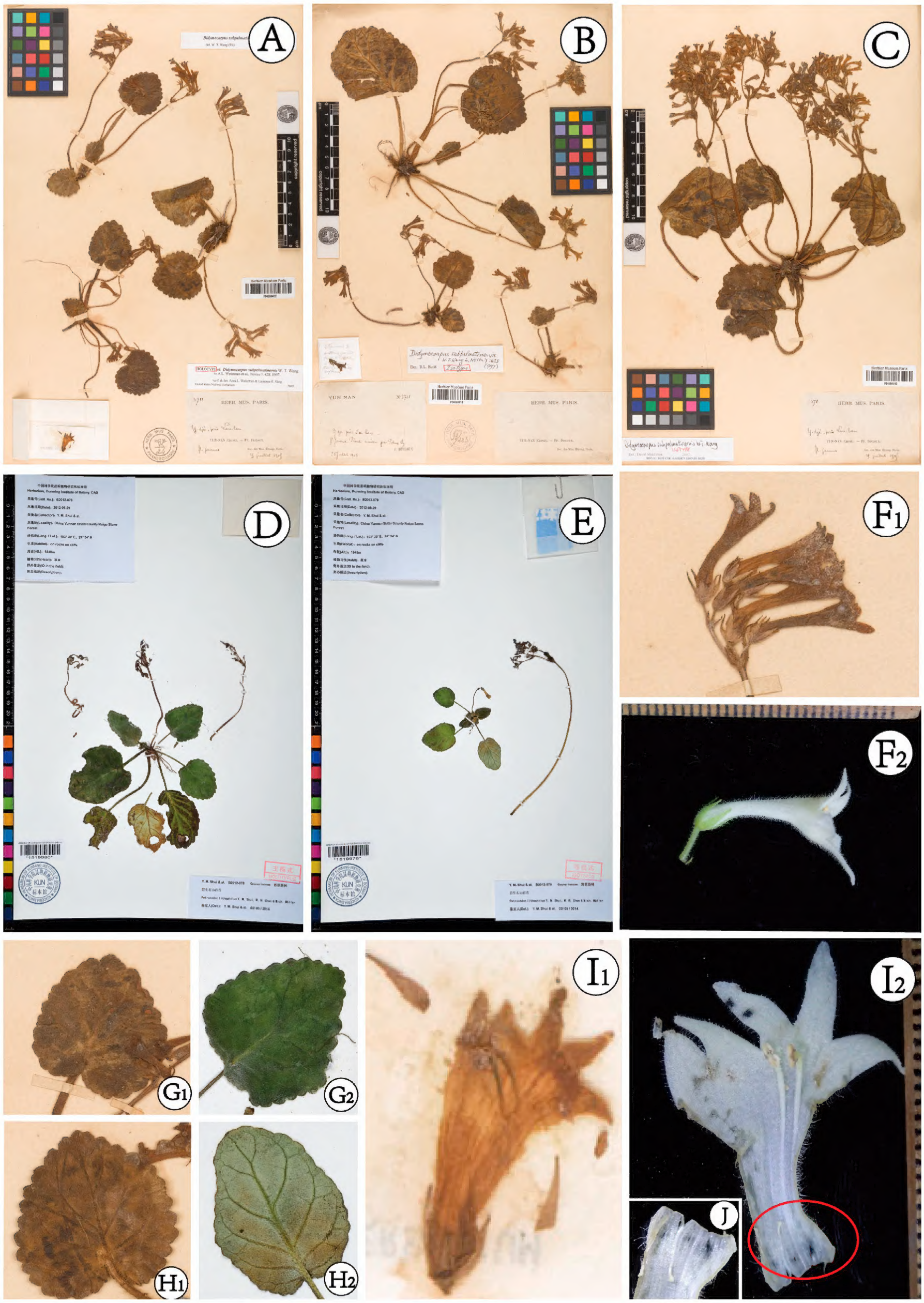

Figure 2. Morphological comparison of *Didymocarpus subpalmatinervis* and *Petrocodon lithophilus* **A–C, F_1–I_1:** *D. subpalmatinervis* **D, E, J, F_2–I_2:** *P. lithophilus* **A** holotype P04060419 **B** isotype P04060165 **C** isotype P04060418 **D** holotype KUN-1519980 **E** Isotype KUN-1519978 **F** flower **G** abaxial surface of Leaves **H** adaxial surface of Leaves **I** opened corolla **J** staminodes.

Taxonomic treatment

***Petrocodon subpalmatinervis* (W.T.Wang) F.Wen & Z.L.Li, comb. nov.**
urn:lsid:ipni.org:names:77326781-1

Didymocarpus subpalmatinervis W.T.Wang, *Novon* 7(4): 428–429. 1997. Type: China. Yunnan: Y-dje, near Lou-lan, July 1905, *Fr. Ducloux 3711* (P: holotype P04060419!; isotypes P04060165!, P04060418!). Basionym.

= *Petrocodon lithophilus* Y.M.Shui, W.H.Chen & Mich.Möller, *Sys. Bot.* 39(1): 325. 2014. syn. nov. Type: China. Yunnan: Shilin County, Naigu Stone Forest, alt. 1848 m, on rocks on cliffs, 29 August 2012, *Y.M. Shui et al. B2012–078* (**KUN**: holotype KUN-1519980!; isotype KUN-1519978!).

Chinese Vernacular name. 掌脉石山苣苔 (Zhǎng Mài Shí Shān Jù Tái).

Distribution and habitat. This species is endemic to Shilin County, Yunnan Province, China, growing in narrow cracks on rocks. Accompanying plants include other shade herbs and trees.

Proposed IUCN conservation status. Naigu Stone Forest is a famous scenic spot for many tourists. The population of *Petrocodon subpalmatinervis* is easily affected by human activities. For example, tourists probably collect the conspicuous flowers of *P. subpalmatinervis* while they visit the scenic spot and walk along the trails among the Karst peaks and hills of Naigu Shilin. As mature individuals are easily damaged, the population will likely gradually decline year by year. According to the results of our field investigation in the type locality and adjacent regions, the EOO and AOO of *P. subpalmatinervis* are about 800 km^2 and 30 km^2. Despite the severe drought in the second half of 2022 seriously influencing the plant population, there is still a high number of individuals (more than 5 000) surviving in the scenic spot. In addition, authors also found several small populations (total>1 000) in the Karst landscape surrounding the type locality, Naigu Shilin. Following the *IUCN Red List Categories and Criteria* (IUCN 2022), this species is evaluated as Endangered [EN B1ab (i, ii, iii, iv)+2ab (i, ii, iii, iv)].

Notes. When Wang published the protologue of *Didymocarpus subpalmatinervis*, the collection date read 1909. But, on the website of **CVH** and the herbarium **P**, the collection date of the information of the specimen we consulted was 1905. Their two different collection years are confusing. We carefully compared the labels of three type specimens of *D. subpalmatinervis* with the collection number '*3711*' and found that the collector's writing habits might have caused this misunderstanding. Ducloux's personal collection number increased with time like many collectors. For example, the collection number of *Berberis bodinieri* H.Lév. he collected in 1896 was '*0004*'; in 1904, the collection number of *Potamogeton distinctus* A. Benn. was '*2571*'; in 1905, he collected *Cornus capitata* Wall. at the same place (Y-dje near Lou-lan) with the collection number '*3715*'; In 1909, the collection number of *Merremia yunnanensis* (Courchet & Gagnep.) R.C.Fang has reached '*6398*'. Therefore, it seems likely that the specimens of *D. subpalmatinervis* with the collection number *Fr. Ducloux 3711* were collected in 1905.

For some species published decades or even a hundred years ago, obtaining molecular materials for systematic analysis is challenging because there may be only one type specimen or a few specimens, or they are stored in a foreign herbarium (Wei 2018; Kong et al. 2021). Despite this complicated background,

it is still reasonable and accurate to conduct an analysis and verification of the type specimen of the dubious species. When combined with the collecting history of the Ducloux, and the current situation of the existing population (Wei et al. 2022), we are confident about the name and status.

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Author contributions

ZL, ZH and DC inspected the specimens of the species. ZL, FW, and ZH performed the data analysis. ZL and ZH wrote the manuscript. FW and XH revised the manuscript. All authors have read and approved the final manuscript.

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Data availability

All of the data that support the findings of this study are available in the main text.

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